GSM*
(Global System For Mobile Communications)

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***ABSTRACT* :- Mobile communication is continuously one of the hottest areas that are developing at a booming speed, with advanced techniques emerging in all the fields of mobile and wireless communications. This paper deals with the comparative study of cellular technologies namely "GSM".Global System for Mobile communications or GSM uses digital modulation to improve voice quality but the network offers limited data service.**

Keywords :-—Communications; Base & Mobile Stations; TDMA ; SIM ; GPRS;

I. INTRODUCTION

GSM (Global System for Mobile Communications, originally Groupe Spécial Mobile) is widely used mobile communication system in the world. GSM is an open and digital cellular technology used for transmitting mobile voice and data services operates at the 850MHz, 900MHz, 1800MHz and 1900MHz frequency bands.

GSM is a trademark owned by the GSM Association. It may also refer to the (initially) most common voice codec used, Full Rate.

"GSM" is a standard developed by the European Telecommunications Standards Institute (ETSI) to describe the protocols for second-generation digital cellular networks used by mobile devices such as tablets, first deployed in Finland in December 1991. As of 2014, it has become the global standard for mobile communications – with over 90% market share, operating in over 193 countries and territories.

2G networks developed as a replacement for first generation (1G) analog cellular networks, and the GSM standard originally described as a digital, circuit-switched network optimized for full duplex voice telephony. This expanded over time to include data communications, first by circuit-switched transport, then by packet data transport via GPRS (General Packet Radio Services) and EDGE (Enhanced Data rates for GSM Evolution, or EGPRS).

Subsequently, the 3GPP developed third-generation (3G) UMTS standards, followed by fourth-generation (4G) LTE Advanced standards, which do not form part of the ETSI GSM standard.

Fig. GSM Logo

The GSM logo is used to identify compatible devices and equipment. The dots symbolize three clients in the home network and one roaming client.

II. HISTORY

In 1983 work began to develop a European standard for digital cellular voice telecommunications when the European Conference of Postal and Telecommunications Administrations (CEPT) set up the Groupe Spécial Mobile

committee and later provided a permanent technical-support group based in Paris. Five years later, in 1987, 15 representatives from 13 European countries signed

a memorandum of understanding in Copenhagen to develop and deploy a common cellular telephone system across Europe, and EU rules were passed to make GSM a mandatory standard.The decision to develop a continental standard eventually resulted in a unified, open, standard-based network which was larger than that in the United States.

In February 1987 Europe produced the very first agreed GSM Technical Specification. Ministers from the four big EU countries cemented their political support for GSM with the Bonn Declaration on Global Information Networks in May and the GSM MoU was tabled for signature in September. The MoU drew in mobile operators from across Europe to pledge to invest in new GSM networks to an ambitious common date.

In this short 38-week period the whole of Europe (countries and industries) had been brought behind GSM in a rare unity and speed guided by four public officials: Armin Silberhorn (Germany), Stephen Temple (UK), Philippe Dupuis (France), and Renzo Failli (Italy). In 1989 the Groupe Spécial Mobile committee was

transferred from CEPT to the European Telecommunications Standards Institute (ETSI).

In parallel France and Germany signed a joint development agreement in 1984 and were joined by Italy and the UK in 1986. In 1986, the European Commission proposed reserving the 900 MHz spectrum band for GSM. The former Finnish prime minister Harri Holkeri made the world's first GSM call on July 1, 1991, calling Kaarina Suonio (mayor of the city of Tampere) using a network built by Telenokia and Siemens and operated by Radiolinja. The following year saw the sending of the first short ymessaging service (SMS or "text message") message, and Vodafone UK and Telecom Finland signed the first international roaming agreement.

Work began in 1991 to expand the GSM standard to the 1800 MHz frequency band and the first 1800 MHz network became operational in the UK by 1993, called and DCS 1800. Also that year, Telecom Australia became the first network operator to deploy a GSM network outside Europe and the first practical hand-held GSM mobile phone became available.

In 1995 fax, data and SMS messaging services were launched commercially, the first 1900 MHz GSM network became operational in the United States and GSM subscribers worldwide exceeded 10 million. In the same year, the GSM Association formed. Pre-paid GSM SIM cards were launched in 1996 and worldwide GSM subscribers passed 100 million in 1998.

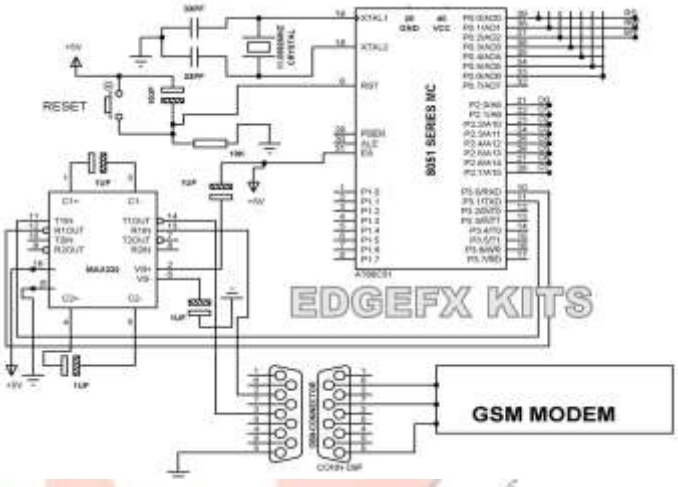
In 2000 the first commercial GPRS services were launched and the first GPRS-compatible handsets became available for sale. In 2001, the first UMTS (W-CDMA) network was launched, a 3G technology that is not part of GSM. Worldwide GSM subscribers exceeded 500 million. In 2002, the first Multimedia Messaging Service (MMS) was introduced and the first GSM network in the 800 MHz frequency band became operational. EDGE services first became operational in a network in 2003, and the number of worldwide GSM subscribers exceeded 1 billion in 2004.

By 2005 GSM networks accounted for more than 75% of the worldwide cellular network market, serving 1.5 billion subscribers. In 2005, the first HSDPA-capable network also became operational. The first HSUPA network launched in 2007. (High-Speed Packet Access (HSPA) and its uplink and downlink versions are 3G technologies, not part of GSM.) Worldwide GSM subscribers exceeded three billion in 2008.

The GSM Association estimated in 2010 that technologies defined in the GSM standard served 80% of the mobile market, encompassing more than 5 billion people across more than 212 countries and territories, making GSM the most ubiquitous of the many standards for cellular networks.

GSM is a second-generation (2G) standard employing time-division multiple-Access (TDMA) spectrum-sharing, issued by the European Telecommunications Standards Institute (ETSI). The GSM standard does not include the 3G Universal Mobile Telecommunications System (UMTS) code division multiple access (CDMA) technology nor the 4G LTE orthogonal frequency-division multiple access (OFDMA) technology standards issued by the 3GPP.

GSM, for the first time, set a common standard for Europe for wireless networks. It was also adopted by many countries outside Europe. This allowed subscribers to use other GSM networks that have roaming agreements with each other. The common standard reduced research and development costs, since hardware and software could be sold with only minor adaptations for the local market.



TELSTRA IN AUSTRALIA SHUT DOWN ITS 2G GSM NETWORK ON DECEMBER 1, 2016, THE FIRST MOBILE NETWORK OPERATOR TO DECOMMISSION A GSM NETWORK. THE SECOND MOBILE PROVIDER TO SHUT DOWN ITS GSM NETWORK (ON JANUARY 1, 2017) WAS AT&T MOBILITY FROM THE UNITED STATES. OPTUS IN AUSTRALIA COMPLETED THE SHUT DOWN ITS 2G GSM NETWORK ON AUGUST 1, 2017, PART OF THE OPTUS GSM NETWORK COVERING WESTERN AUSTRALIA AND THE NORTHERN TERRITORY HAD EARLIER IN THE YEAR BEEN SHUT DOWN IN APRIL 2017.SINGAPORE SHUT DOWN 2G SERVICES ENTIRELY IN APRIL 2017.

III. GSM SYSTEM

There are various cell sizes in a GSM system such as macro, micro, pico and umbrella cells. Each cell varies as per the implementation domain. There are five different cell sizes in a GSM network macro, micro, pico and umbrella cells. The coverage area of each cell varies according to the implementation environment.

Time Division Multiple Access

TDMA technique relies on assigning different time slots to each user on the same frequency. It can easily adapt to data transmission and voice communication and can carry 64kbps to 120Mbps of data rate.

GSM MODEM

FiG. GSM Modem

A GSM modem is a device which can be either a mobile phone or a modem device which can be used to make a computer or any other processor communicate over a network. A GSM modem requires a SIM card to be operated and operates over a network range subscribed by the network operator. It can be connected to a computer through serial, USB or Bluetooth connection.

A GSM modem can also be a standard GSM mobile phone with the appropriate cable and software driver to connect to a serial port or USB port on your computer. GSM modem is usually preferable to a GSM mobile phone. The GSM modem has wide range of applications in transaction terminals, supply chain management, security applications, weather stations and GPRS mode remote data logging.

Working of GSM Module:-

From the below circuit, a GSM modem duly interfaced to the MC through the level shifter IC Max232. The SIM card mounted GSM modem upon receiving digit command by SMS from any cell phone send that data to the MC through serial communication. While the program is executed, the GSM modem receives command 'STOP' to develop an output at the MC, the contact point of which are used to disable the ignition switch. The command so sent by the user is based on an intimation received by him through the GSM modem 'ALERT' a programmed message only if the input is driven low. The complete operation is displayed over 16×2 LCD display.

Fig. GSM Modem Circuit

GSM Architecture:-

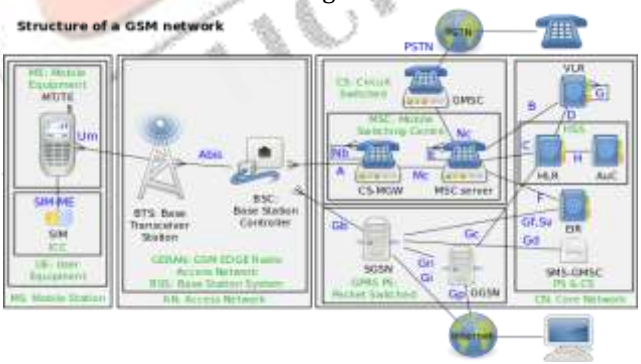
Fig.Network Structure

A GSM network consists of the following components:

- **A Mobile Station:** It is the mobile phone which consists of the transceiver, the display and the processor and is controlled by a SIM card operating over the network.
- **Base Station Subsystem:** It acts as an interface between the mobile station and the network subsystem. It consists of the Base Transceiver Station which contains the radio transceivers and handles the protocols for communication with mobiles. It also consists of the Base Station Controller which controls the Base Transceiver station and acts as a interface between the mobile station and mobile switching centre.
- **Network Subsystem:** It provides the basic network connection to the mobile stations. The basic part of the Network Subsystem is the Mobile Service Switching Centre which provides access to different networks like ISDN, PSTN etc. It also consists of the Home Location Register and the Visitor Location Register which provides the call routing and roaming capabilities of GSM. It also contains the Equipment Identity Register which maintains an account of all the mobile equipments wherein each mobile is identified by its own IMEI number. IMEI stands for International Mobile Equipment Identity.
- **GPRS Core Network:** the optional part which allows packet-based Internet connections
- **Operations support system (OSS):** network maintenance

Features of GSM Module:-

- Improved spectrum efficiency
- International roaming



- Compatibility with integrated services digital network (ISDN)
- Support for new services.
- SIM phonebook management
- Fixed dialing number (FDN)
- Real time clock with alarm management
- High-quality speech
- Uses encryption to make phone calls more secure

Short message service (SMS)

IV. ADVANTAGES & DISADVANTAGES

Advantages of GSM

Following are the advantages of GSM:-

1. GSM technology has been matured since long and hence GSM mobile mobile phones and modems are widely available across the world.
2. It provides very cost effective products and solutions.
3. The GSM based networks (i.e. base stations) are deployed across the world and hence same mobile phone works across the globe. This leverages cost benefits as well as provides seamless wireless connectivity. This will help users avail data and voice services without any disruption. Hence international roaming is not a concern.
4. Advanced versions of GSM with higher number of antennas will provide high speed download and upload of data.
5. SAIC and DAIC techniques provide very high transmission quality. SAIC stands for Single Antenna Interference Cancellation technique while DAIC stands for Dual antenna interference cancellation.
6. It is easy to maintain GSM networks due to availability of large number of network engineers at affordable cost. This will help in revenue increase by the telecom operators.
7. The phone works based on SIM card and hence it is easy to change the different varieties of phones by users.
8. The GSM signal does not have any deterioration inside the office and home premises.
9. It is easy to integrate GSM with other wireless technology based devices such as CDMA, LTE etc.

Disadvantages of GSM

Following are the disadvantages of GSM:

1. Many of the GSM technologies are patented by Qualcomm and hence licenses need to be obtained from them.
2. In order to increase the coverage repeaters are required to be installed.
3. GSM provides limited data rate capability, for higher data rate GSM advanced version devices are used.
4. GSM uses FTDMA access scheme. Here multiple users share same bandwidth and hence will lead to interference when more number of users are using the GSM service. In order to avoid this situation, robust frequency correction algorithms are used in mobile phones and base stations.
5. GSM uses pulse based burst transmission technology and hence it interferes with certain electronics. Due to this fact airplanes, petrol bunks and hospitals prevent use of GSM based mobile or other gadgets.

V. GSM SERVICES

Global System for Mobile Communications (GSM) services are a standard collection of applications and features available to mobile phone subscribers all over the world. The GSM standards are defined by the 3GPP collaboration and implemented in hardware and software by equipment manufacturers and mobile phone operators. The common standard makes it possible to use the same phones with different companies' services, or even roam into different countries. GSM is the world's most dominant mobile phone standard.

The design of the service is moderately complex because it must be able to locate a moving phone anywhere in the world, and accommodate the relatively small battery capacity, limited input/output capabilities, and weak radio transmitters on mobile devices.

A) Accessing A GSM Network

In order to gain access to GSM services, a user needs three things:

- A billing relationship with a mobile phone operator. This is usually either where services are paid for in advance of them being consumed (prepaid), or where bills are issued and settled after the service has been consumed (postpaid).
- A mobile phone that is GSM compliant and operates at the same frequency as the operator. Most phone companies sell phones from third-party manufacturers.
- A subscriber identity module (SIM card), which is activated by the operator once the billing relationship is established. After activation the card is then programmed with the subscriber's Mobile Subscriber Integrated Services Digital Network Number (MSISDN) (the telephone number). Personal information such as contact numbers of friends and family can also be stored on the SIM by the subscriber.

After subscribers sign up, information about their identity (telephone number) and what services they are allowed to access are stored in a "SIM record" in the Home Location Register (HLR).

Once the SIM card is loaded into the phone and the phone is powered on, it will search for the nearest mobile phone mast (also called a Base Transceiver Station/BTS) with the strongest signal in the operator's frequency band. If a mast can be successfully contacted, then there is said to be coverage in the area. The phone then identifies itself to the network through the control channel. Once this is successfully completed, the phone is said to be attached to the network.

The key feature of a mobile phone is the ability to receive and make calls in any area where coverage is available. This is generally called roaming from a customer perspective, but also called visiting when describing the underlying technical process. Each geographic area has a database called the Visitor Location Register (VLR), which contains details of all the mobiles currently in that area. Whenever a phone attaches, or visits, a new area, the Visitor Location Register must contact the Home Location Register to obtain the details for that phone. The current cellular location of the phone (i.e., which BTS it is at) is entered into the VLR record and will be used during a process called paging when the GSM network wishes to locate the mobile phone.

Every SIM card contains a secret key, called the Ki, which is used to provide authentication and encryption services. This is useful to prevent theft of service, and also to prevent "over the air" snooping of a user's activity. The network does this by utilising the Authentication Center and is accomplished without transmitting the key directly.

Every GSM phone contains a unique identifier (different from the phone number), called the International Mobile Equipment Identity (IMEI). This can be found by dialing *#06#. When a phone contacts the network, its IMEI may be checked against the Equipment Identity Register to locate stolen phones and facilitate monitoring.

B) Speech Encoding

During a GSM call, speech is converted from analogue sound waves to digital data by the phone itself, and transmitted through the mobile phone network by digital means. (Though older parts of the fixed Public Switched Telephone Network may use analog transmission.)

The digital algorithm used to encode speech signals is called a codec. The speech codecs used in GSM are called Half-Rate (HR), Full-Rate (FR), Enhanced Full-Rate (EFR), Adaptive Multirate (AMR) and Wideband AMR also known as HD voice. All codecs except AMR operate with a fixed data rate and error correction level.

C) Data Transmission

The GSM standard also provides separate facilities for transmitting digital data. This allows a mobile phone to act like any other computer on the Internet, sending and receiving data via the Internet Protocol.
The mobile may also be connected to a desktop computer, laptop, or PDA, for use as a network interface (just like a modem or Ethernet card, but using one of the GSM data protocols described below instead of a PSTN-compatible audio channel or an Ethernet link to transmit data). Some GSM phones can also be controlled by a standardised Hayes AT command set through a serial cable or a wireless link (using IRDA or Bluetooth). The AT commands can control anything from ring tones to data compression algorithms.

In addition to general Internet access, other special services may be provided by the mobile phone operator, such as SMS.

Circuit-Switched Data Protocols

A circuit-switched data connection reserves a certain amount of bandwidth between two points for the life of a connection, just as a traditional phone call allocates an audio channel of a certain quality between two phones for the duration of the call.

Two circuit-switched data protocols are defined in the GSM standard: Circuit Switched Data (CSD) and High-Speed Circuit-Switched Data (HSCSD). These types of connections are typically charged on a per-second basis, regardless of the amount of data sent over the link. This is because a certain amount of bandwidth is dedicated to the connection regardless of whether or not it is needed.

Circuit-switched connections do have the advantage of providing a constant, guaranteed quality of service, which is useful for real-time applications like video conferencing.

General Packet Radio Service (GPRS)

The General Packet Radio Service (GPRS) is a packet-switched data transmission protocol, which was incorporated into the GSM standard in 1997. It is backwards-compatible with systems that use pre-1997 versions of the standard. GPRS does this by sending packets to the local mobile phone mast (BTS) on channels not being used by circuit-switched voice calls or data connections. Multiple GPRS users can share a single unused channel because each of them uses it only for occasional short bursts.
The advantage of packet-switched connections is that bandwidth is only used when there is actually data to transmit. This type of connection is thus generally billed by the kilobyte instead of by the second, and is usually a cheaper alternative for applications that only need to send and receive data sporadically, like instant messaging.

GPRS is usually described as a 2.5G technology; see the main article for more information.

Short Message Service (SMS)

Short Message Service (more commonly known as text messaging) has become the most used data application

on mobile phones, with 74% of all mobile phone users worldwide already as active users of SMS, or 2.4 billion people by the end of 2007.

SMS text messages may be sent by mobile phone users to other mobile users or external services that accept SMS. The messages are usually sent from mobile devices via the Short Message Service Centre using the MAP protocol.

The SMSC is a central routing hubs for Short Messages. Many mobile service operators use their SMSCs as gateways to external systems, including the Internet, incoming SMS news feeds, and other mobile operators (often using the de facto SMPP standard for SMS exchange).

The SMS standard is also used outside of the GSM system; see the main article for details.

VI. GSM SECURITY

GSM was intended to be a secure wireless system. It has considered the user authentication using a pre-shared key and challenge-response, and over-the-air encryption. However, GSM is vulnerable to different types of attack, each of them aimed at a different part of the network.

The development of UMTS introduced an optional Universal Subscriber Identity Module (USIM), that uses a longer authentication key to give greater security, as well as mutually authenticating the network and the user, whereas GSM only authenticates the user to the network (and not vice versa). The security model therefore offers confidentiality and authentication, but limited authorization capabilities, and no non-repudiation.
GSM uses several cryptographic algorithms for security. The A5/1, A5/2, and A5/3 stream ciphers are used for ensuring over-the-air voice privacy. A5/1 was developed first and is a stronger algorithm used within Europe and the United States; A5/2 is weaker and used in other countries. Serious weaknesses have been found in both algorithms: it is possible to break A5/2 in real-time with a ciphertext-only attack, and in January 2007, The Hacker's Choice started the A5/1 cracking project with plans to use FPGAs that allow A5/1 to be broken with a rainbow table attack. The system supports multiple algorithms so operators may replace that cipher with a stronger one.

Since 2000 different efforts have been made in order to crack the A5 encryption algorithms. Both A5/1 and A5/2 algorithms have been broken, and their cryptanalysis has been revealed in the literature. As an example, Karsten Nohl (de) developed a number of rainbow tables (static values which reduce the time needed to carry out an attack) and have found new sources for known plaintext attacks. He said that it is possible to build "a full GSM interceptor...from open-source components" but that they had not done so because of legal concerns. Nohl claimed that he was able to intercept voice and text conversations by impersonating another user to listen to voicemail, make calls, or send text messages using a seven-year-old Motorola cellphone and decryption software available for free online.

GSM uses General Packet Radio Service (GPRS) for data transmissions like browsing the web. The most commonly deployed GPRS ciphers were publicly broken in 2011.

The researchers revealed flaws in the commonly used GEA/1 and GEA/2 ciphers and published the open-source "gprsdecode" software for sniffing GPRS networks. They also noted that some carriers do not encrypt the data (i.e., using GEA/0) in order to detect the use of traffic or protocols they do not like (e.g., Skype), leaving customers unprotected. GEA/3 seems to remain relatively hard to break and is said to be in use on some more modern networks. If used with USIM to prevent connections to fake base stations and downgrade attacks, users will be protected in the medium term, though migration to 128-bit GEA/4 is still recommended.

VII. CONCLUSION

The GSM mobile terminal has become one of the items that are constantly with us. Just like our wallet/purse, keys or watch, the GSM mobile terminal provides us a communication channel that enables us to communicate with the world. The requirement for a person to be reachable or to call anyone at any time is very appealing.

In this paper, as the name says paper is based on GSM network technology for transmission of SMS from sender to receiver. SMS sending and receiving is used for ubiquitous access of appliances and allowing breach control at home. The system proposes two sub-systems. Appliance control subsystem enables the user to control home appliances remotely and the security alert subsystem gives the automatic security monitoring.

GSM will allow communication anywhere, anytime, and with anyone. The functional architecture of GSM employing intelligent networking principles, and its ideology, which provides the development of GSM is the first step towards a true personal communication system that enough standardization to ensure compatibility.

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